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INFLATOR

Field of the Invention

The present invention relates to an inflator which provides inflation fluid to inflate an inflatable vehicle occupant protection device and, more specifically, to an inflator in which a rupturable closure member is supported.

Background of the Invention

An inflatable vehicle occupant protection device, such as a side curtain or an air bag, is inflated upon the occurrence of a vehicle condition requiring inflation of the side curtain or air bag. When inflation is required, an inflator is actuated to provide inflation fluid which inflates the side curtain or air bag into the vehicle occupant compartment.

The inflator includes a container defining an inflation fluid pressure chamber with an outlet passage. A rupturable closure member is fixed to the container to block flow of inflation fluid through the

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outlet passage. The inflator further includes an electrically actuatable initiator which, when actuated, causes the closure member to rupture so that inflation fluid in the pressure chamber can flow from the inflator.

Summary of the Invention

The present invention is an inflator for providing inflation fluid to inflate an inflatable vehicle occupant protection device. The inflator includes a container storing inflation fluid under pressure. The container has an outlet passage through which inflation fluid flows from the container. A rupturable closure member fixed to the container blocks flow of inflation fluid through the outlet passage.

A support for the rupturable closure member defines a chamber adjacent the rupturable closure member. The rupturable closure member has a first portion deformed into the chamber by the pressure of the inflation fluid and a second ring-shaped portion encircling the first portion. An initiator ruptures the closure member by shearing the first portion from the second portion when actuated.

Brief Description of the Drawings

The foregoing and other features of the present invention will become apparent to one skilled in the art to which the present invention relates upon
5 consideration of the following description of the invention with reference to the accompanying drawings, wherein:

Fig. 1 is a schematic illustration of a vehicle safety apparatus embodying the present invention;

10 Fig. 2 is an enlarged sectional view of an inflator of the safety apparatus of Fig. 1;

Fig. 3 is an enlarged view of a portion of the inflator of Fig. 2;

15 Fig. 4 is a view similar to Fig. 3 showing a rupturable closure member prior to inflation fluid entering a container which is closed by the closure member;

20 Fig. 5 is a view similar to Fig. 3 showing the closure member after an initiator of the inflator has been actuated;

Fig. 6 is a view similar to Fig. 5 showing a portion of the closure member sheared away; and

A handwritten mark, possibly a signature or initials, consisting of a stylized 'H' or '4' shape with a vertical line extending upwards from the right side.

Fig. 7 is a view similar to Fig. 6 showing the closure member during flow of inflation fluid from the container.

Description of a Preferred Embodiment

5 The present invention relates to a vehicle occupant safety apparatus. In particular, the present invention relates to an inflatable vehicle occupant protection device, such as a side curtain assembly, for helping to protect a vehicle occupant in the event of a side impact to a vehicle. As representative of the present invention, Fig. 1 illustrates schematically a vehicle safety apparatus 10 for helping to protect an occupant of a vehicle 12.

10 The safety apparatus 10 includes an inflatable vehicle occupant protection device in the form of a side curtain 14. The side curtain 14 is mounted adjacent the side structure 16 of the vehicle 12. A fill tube 20 extends into the side curtain 14. An actuatable inflator 22, when actuated, directs fluid into the fill tube 20 which, in turn, directs fluid into the inflatable side curtain 14 to inflate the side curtain. The side curtain 14 is inflated from a deflated and stowed condition (not shown) to an inflated condition, as illustrated in Fig. 1. In its

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inflated condition, the side curtain 14 is positioned between the side structure of the vehicle and a vehicle occupant. The side curtain 14 is made of a material having a low permeability so that the side curtain
5 remains inflated for a long period of time, such as seven seconds or longer.

The vehicle 12 includes a sensor 24, known in the art, for sensing a side impact to the vehicle and/or a vehicle rollover, to actuate the inflator 22. The
10 sensor 24 may include vehicle electric circuitry for actuating the inflator 22 in response to sensing a side impact to the vehicle and/or a vehicle rollover. The sensor 24 provides an electric signal over lead wires 26 to the inflator 22, when the inflator is to be
15 actuated.

The inflator 22 (Fig. 2) comprises a source of inflation fluid for the side curtain 14. The inflator 22 includes a container 30 having a generally elongate configuration including a main body portion 32 and an end cap 34. The end cap 34 is affixed to an
20 open end 33 of the main body portion 32 by friction welding. The end cap 34 could, however, be connected to the main body portion 32 in any manner known in the

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art, such as using laser welds, brazing or screw threads.

Fig 2

5 The main body portion 32 of the container 30 has a tubular, cylindrical configuration including an axially extending cylindrical side wall 40. The side wall 40 has a cylindrical inner surface 42 centered on a longitudinal central axis 44 of the inflator 22. A second end portion 46 of the main body portion 32 is closed by a domed end wall 48. The side wall 44 and the end wall 48 define a chamber 50 in the container 30.

10 The chamber 50 contains pressurized inflation fluid. The inflation fluid stored in the chamber 50 preferably consists essentially of helium at a storage pressure within the range of about 4,000 psi to about 15 7,000 psi. The inflation fluid may, however, have any other composition and storage pressure suitable for inflating the side curtain 14.

20 The end cap 34 (Figs. 2 and 3) of the container 30 has a generally cylindrical configuration including an axially extending cylindrical side wall 70 and an end surface 72. An annular array of inflation fluid outlet passages 76 are formed in the side wall 70 of the end cap 34. The flow area, number and/or configuration of

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the outlet passages 76 may be selected to restrict or otherwise control the flow of inflation fluid into the side curtain 14 through the fill tube 20, which is connected in a known manner to the end cap 34, as
5 illustrated schematically in Fig. 1.

The end cap 34 includes a surface 78 (Fig. 2) which extends generally parallel to the end surface 72. A passage 80 extends axially through the end cap 34 and intersects the surface 78. The passage 80 conducts
10 inflation fluid from the chamber 50 to the outlet passages 76. The passage 80 is centered on the axis 44.

A rupturable closure member 92 (Figs. 2 and 3), such as a rupture disk, is affixed to the surface 78 by
15 a laser weld 94. The rupture disk 92 could, however, be connected to the surface 78 in any manner well known in the art, such as by brazing, projection welding or electron beam welding. The rupture disk 92 is centered on the axis 44 and blocks the flow of inflation fluid
20 through the passage 80 and to the passages 76.

An initiator 98 centered on the axis 44 is housed in a hollow support 100 which supports the closure member 92. Lead wires 26 extend from connector pins 101 of the initiator 98 to receive the electrical

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signal from the sensor 24. The support 100 is centered on the axis 44. The support 100 (Figs. 2 and 3) has a flange 102 which engages the end surface 72 of the end cap 34. The flange 102 extends radially outward of the support 100 and also engages a radially extending base 104 of the initiator 98.

An annular rim portion 106 extends from the end surface 72. The rim portion 106 initially projects axially away from the end surface 72 and is subsequently crimped around the base 104 of the initiator 98 to hold the initiator and the support 100 in place in the end cap 34. Alternatively, the initiator 98 and the support 100 may be welded to the end cap 34 to retain the initiator and the support in the end cap.

The support 100 projects inwardly along the axis 44 into abutment with the closure member 92. The support 100 is thus mounted in a load bearing relationship with the closure member 92. More specifically, the closure member 92 is subjected to the storage pressure of the inflation fluid in the chamber 50. Therefore, the closure member 92 transmits a fluid storage pressure force axially outward against the support 100. The support 100, in turn, transmits

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the storage pressure force to the end surface 72 of the end cap 34 where the initiator 98 adjoins the crimped rim 106 of the end surface 72.

5 The support 100 defines a chamber 110. An end portion 112 of the support 100 has a circular rim 114 engaging the closure member 92. The rim 114 defines an opening 116 into the chamber 110.

10 The closure member 92 has a central dome-shaped portion 122 extending into the chamber 110. A portion 124 of the closure member 92 encircles the dome-shaped portion 122. The portion 124 of the closure member 92 extends from the circular rim 114 of the support 100 to the surface 78 of the end cap 34. A portion 126 of the closure member 92 encircles the
15 portion 124 and is welded to the surface 78.

When the chamber 50 is not filled with inflation fluid, as shown in Fig. 4, the closure member 92 is a flat disk. The closure member 92 is spaced from the rim 114 of the support 100. During the subsequent
20 loading of the closure member 92 by the pressure of the inflation fluid, the closure member is stressed and undergoes plastic deformation into the chamber 110. The closure member 92 deforms from the flat disk shown in Fig. 4 into the shape shown in Fig. 3. A work

hardening of the closure member 92 occurs during the plastic deformation.

Upon receiving of an electric signal from the sensor 24, the initiator 98 is actuated in a known manner to produce a shock wave and combustion gas. The pressure of the combustion gas, coupled with the shock wave, acts on the dome-shaped portion 122 of the closure member 92 to reverse the dome from the position shown in Fig. 3 to the position shown in Fig. 5.

The large movement of the dome 122 shears the dome out of the closure member 92, as shown in Fig. 6. The portion 124 of the closure member 92 continues to block the passage 80. The pressure generated by the inflation fluid is supported only by the strength of the portion 124 when the dome 122 is removed. The pressure of the inflation fluid causes the portion 124 of the closure member 92 to rip and petal away from the support 100 to the position shown in Fig. 7, providing a flow of the inflation fluid through the passage 80 and to the outlet passages 76 and thereafter to the side curtain 14.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications. For example, although the

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